

**PATENT COOPERATION TREATY**  
**PCT**  
**INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY**  
(Chapter II of the Patent Cooperation Treaty)  
(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference 8096WO	<b>FOR FURTHER ACTION</b> See Form PCT/IPEA/416	
International application No. PCT/AU2004/001681	International filing date (day/month/year) 2 December 2004	Priority date (day/month/year) 2 December 2003
International Patent Classification (IPC) or national classification and IPC Int. Cl. <sup>7</sup> B62D 3/12, 6/00 // B62D 101:00, 111:00		
Applicant BISHOP INNOVATION LIMITED et al		

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 3 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
  - a. ☒ (sent to the applicant and to the International Bureau) a total of 4 sheets, as follows:
    - ☒ sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
    - ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
  - b. ☐ (sent to the International Bureau only) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or table related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

<input checked="" type="checkbox"/> Box No. I	Basis of the report
<input type="checkbox"/> Box No. II	Priority
<input type="checkbox"/> Box No. III	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
<input type="checkbox"/> Box No. IV	Lack of unity of invention
<input checked="" type="checkbox"/> Box No. V	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
<input type="checkbox"/> Box No. VI	Certain documents cited
<input type="checkbox"/> Box No. VII	Certain defects in the international application
<input type="checkbox"/> Box No. VIII	Certain observations on the international application

Date of submission of the demand 6 July 2005	Date of completion of the report 10 November 2005
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer  R. SUBBARAYAN Telephone No. (02) 6283 2377

**Box No. I**      **Basis of the report**

1. With regard to the language, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ This report is based on translations from the original language into the following language which is the language of a translation furnished for the purposes of:

- ☐ international search (under Rules 12.3 and 23.1 (b))
- ☐ publication of the international application (under Rule 12.4)
- ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the elements of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

☐ the international application as originally filed/furnished

☒ the description:

pages 1-4, 7-16 as originally filed/furnished

pages\* 5, 6 received by this Authority on 6 July 2005 with the letter of 5 July 2005

pages\* received by this Authority on with the letter of

☒ the claims:

pages as originally filed/furnished

pages\* as amended (together with any statement) under Article 19

pages\* 17, 18 received by this Authority on 6 July 2005 with the letter of 5 July 2005

pages\* received by this Authority on with the letter of

☒ the drawings:

pages 1/10-10/10 as originally filed/furnished

pages\* received by this Authority on with the letter of

pages\* received by this Authority on with the letter of

☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing.

3. ☐ The amendments have resulted in the cancellation of:

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to the sequence listing (*specify*):

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- ☐ the description, pages
- ☐ the claims, Nos.
- ☐ the drawings, sheets/figs
- ☐ the sequence listing (*specify*):
- ☐ any table(s) related to the sequence listing (*specify*):

\* If item 4 applies, some or all of those sheets may be marked "superseded."

## INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.

PCT/AU2004/001681

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement****1. Statement**

Novelty (N)	Claims 1-13	YES
	Claims	NO
Inventive step (IS)	Claims 1-13	YES
	Claims	NO
Industrial applicability (IA)	Claims 1-13	YES
	Claims	NO

**2. Citations and explanations (Rule 70.7)**

D1) WO 2002/036410

D2) US 6467365

D3) US 3908479

None of the documents cited discloses a rack and pinion steering gear having an intermediate gear interposed between, and meshing with, the pinion and the rack, the intermediate gear rotatable about a second axis, the second axis being laterally movable with respect to the housing thereby varying the relationship between the angular displacement of the pinion and the lateral displacement of the rack.

Although citations D2 & D3 disclose steering systems with an intermediate gear interposed between, and meshing with, the pinion and the rack, the centre of rotation of the intermediate gear is restrained from moving laterally and in these designs any lateral movement is considered undesirable. Although citation D1 discloses laterally moving the pinion, a skilled addressee attempting to overcome the problems with this citation would not consider relying on D2 or D3 in combination with D1, because D2 & D3 each teach away from the present invention. The claimed invention is therefore considered novel, inventive and industrially applicable.

## SUMMARY OF INVENTION

The present invention consists of a rack and pinion steering gear for a vehicle, the steering gear comprising a housing, a pinion rotatable about a first axis in the housing, a rack laterally displaceable with respect to the housing, an intermediate gear interposed between, and meshing with, the pinion and with the rack, the intermediate gear rotatable about a second axis, characterised in that the second axis is laterally movable with respect to the housing as a function of at least one vehicle parameter, by an actuator mechanism, thereby varying the relationship between the angular displacement of the pinion and the lateral displacement of the rack as a function of the vehicle parameter.

Preferably, the second axis is eccentric with respect to the central axis of the intermediate gear. Alternatively, the second axis is also the central axis of the intermediate gear.

Preferably, the actuator mechanism comprises a linkage, the linkage maintaining a fixed distance between the second axis and a third axis when the axial load exerted on the linkage is less than a predefined value, the third axis being movable with respect to the housing by the actuator mechanism.

In one preferred embodiment, the actuator mechanism further comprises a crank, the third axis being fixed with respect to the crank and offset from its axis of rotation, thereby arcuately translating the third axis. Preferably, the axis of rotation of the crank is fixed with respect to the housing. Preferably, rotation of the crank is effected by a servomotor.

In another preferred embodiment, the third axis is movable with respect to the housing by a linear recirculating ball nut mechanism.

In yet another preferred embodiment, the third axis is movable with respect to the housing by a hydraulic cylinder controlled by an electrohydraulic servo valve.

Preferably, the linkage incorporates an overload mechanism which causes a shortening or lengthening of the distance between the second and third axes when the axial load exerted on the linkage exceeds the predefined value.

- 5 Preferably, the relationship comprises varying the rack gain, and the parameter is the angle of rotation of a steering wheel connected to the pinion, or the speed of the vehicle.

- 10 Preferably, the relationship comprises the generation of an additional lateral displacement of the rack, and the parameter is the magnitude of side load applied to the vehicle due to cross wind disturbances or road camber.

- 15 Preferably, the intermediate gear comprises two subgears relatively angularly displaceable about the central axis of the intermediate gear and urged by a spring preloading mechanism to minimize mesh backlash between the intermediate gear and the pinion, and between the intermediate gear and the rack.

## **BRIEF DESCRIPTION OF DRAWINGS**

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Fig.1 shows an isometric view the steering gear according to a first embodiment of the present invention, with the housing cover removed to show the front of the actuator mechanism,

- 25 Fig.2 is the same isometric view of the steering gear as shown in Fig. 1, with part of the housing removed to reveal more of the actuator mechanism,

Fig. 3 is a lateral sectional elevation of the steering gear in Fig. 1,

- 30 Fig. 4 is the same isometric view of the steering gear as shown in Fig. 1, with the housing removed,

Fig. 5 is a plan view of the steering gear in Fig. 1, with the housing removed,

## CLAIMS

1. A rack and pinion steering gear for a vehicle, the steering gear comprising a housing, a pinion rotatable about a first axis in the housing, a rack laterally  
5 displaceable with respect to the housing, an intermediate gear interposed between, and meshing with, the pinion and with the rack, the intermediate gear rotatable about a second axis, characterised in that the second axis is laterally movable with respect to the housing as a function of at least one vehicle parameter, by an actuator mechanism, thereby varying the relationship between the angular  
10 displacement of the pinion and the lateral displacement of the rack as a function of the vehicle parameter.
2. A rack and pinion steering gear as claimed in claim 1 wherein the actuator mechanism comprises a linkage, the linkage maintaining a fixed distance between  
15 the second axis and a third axis when the axial load exerted on the linkage is less than a predefined value, the third axis being movable with respect to the housing by the actuator mechanism.
3. A rack and pinion steering gear as claimed in claim 2 wherein the actuator  
20 mechanism further comprises a crank, the third axis being fixed with respect to the crank and offset from its axis of rotation, thereby arcuately translating the third axis on rotation of the crank.
4. A rack and pinion steering gear as claimed in claim 3 wherein the axis of rotation  
25 of the crank is fixed with respect to the housing.
5. A rack and pinion steering gear as claimed in claim 3 wherein rotation of the crank is effected by a servomotor.
- 30 6. A rack and pinion steering gear as claimed in claim 2 wherein the third axis is movable with respect to the housing by a linear recirculating ball nut mechanism.

7. A rack and pinion steering gear as claimed in claim 2 wherein the third axis is movable with respect to the housing by a hydraulic cylinder controlled by an electrohydraulic servo valve.
- 5 8. A rack and pinion steering gear as claimed in claim 2 wherein the linkage incorporates an overload mechanism which causes a shortening or lengthening of the distance between the second and third axes when the axial load exerted on the linkage exceeds the predefined value.
- 10 9. A rack and pinion steering gear as claimed in claim 1 wherein the second axis is eccentric with respect to the central axis of the intermediate gear.
10. A rack and pinion steering gear as claimed in claim 1 wherein the second axis is also the central axis of the intermediate gear.
- 15 11. A rack and pinion steering gear as claimed in claim 1 wherein the relationship comprises varying the rack gain, and the parameter is the angle of rotation of a steering wheel connected to the pinion, or the speed of the vehicle.
- 20 12. A rack and pinion steering gear as claimed in claim 1 wherein the relationship comprises the generation of an additional lateral displacement of the rack, and the parameter is the magnitude of side load applied to the vehicle due to cross wind disturbances or road camber.
- 25 13. A rack and pinion steering gear as claimed in claim 1 wherein the intermediate gear comprises two subgears relatively angularly displaceable about the central axis of the intermediate gear and urged by a spring preloading mechanism to minimize mesh backlash between the intermediate gear and the pinion, and between the intermediate gear and the rack.